

# Functional Plant Biology

## Contents

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Expressing *Arabidopsis thaliana* V-ATPase subunit C in barley (*Hordeum vulgare*) improves plant performance under saline condition by enabling better osmotic adjustment

**Getnet D. Adem, Stuart J. Roy, Yuqing Huang, Zhong-Hua Chen, Feifei Wang, Meixue Zhou, John P. Bowman, Paul Holford and Sergey Shabala**

1147–1159

Salinity is a global problem affecting agriculture. Here we show that overexpression of vacuolar ATPase subunit C is beneficial in improving barley performance under saline conditions. This effect is explained by transgenic lines being able to rely more on the use of Na<sup>+</sup> and K<sup>+</sup> for osmotic adjustment rather than spending energy for de novo synthesis of organic osmolytes.

Roles played by invertase and gene expression in the development of the horn-shaped gall on leaves of *Rhus chinensis*

**Zhen-Yuan Ruan, Xiao-Ming Chen, Pu Yang and Bing-Yi Wang**

1160–1170

Horn-shaped gall is of great value in the food, medicine and industrial field, so the control of its formation will be helpful to increase the products. Vacuolar invertase is related to the rapid expansion of the galls, but ionically bound cell wall invertase is involved in the rapid growth of tissues. This might also be found in other kinds of galls.

Effects of Ni<sup>2+</sup> and Cu<sup>2+</sup> on K<sup>+</sup> and H<sup>+</sup> currents in lily pollen protoplasts

**Maria Breygina, Denis V. Abramochkin, Nikita Maksimov and Igor Yermakov**

1171–1177

Heavy metals disrupt pollen germination in many species, but the mechanism of their action remained unstudied. Here we report that Cu<sup>2+</sup> and Ni<sup>2+</sup> affect H<sup>+</sup> current and K<sup>+</sup> current, respectively, in lily pollen protoplasts; Cu<sup>2+</sup> as well enhances reactive oxygen species accumulation. Thus, we reveal the targets for heavy metals (Cu<sup>2+</sup> and Ni<sup>2+</sup>) in the pollen grain plasma membrane.

Light inhibition of foliar respiration in response to soil water availability and seasonal changes in temperature in Mediterranean holm oak (*Quercus ilex*) forest

**Matthew H. Turnbull, Romà Ogaya, Adrià Barbata, Josep Peñuelas, Joana Zaragoza-Castells, Owen K. Atkin, Fernando Valladares, Teresa E. Gimeno, Beatriz Pías and Kevin L. Griffin**

1178–1193

Leaf respiration is an integral component of plant growth and the global carbon cycle, and it is typically lower during the day than at night. We investigated leaf respiration in Mediterranean holm oak woodland, and found that light inhibition was not strongly related to changes in soil water content or ambient temperature. The findings have implications for predictive models that seek to calculate plant carbon balance.

Variation in shoot tolerance mechanisms not related to ion toxicity in barley

**Joanne Tilbrook, Rhiannon K. Schilling, Bettina Berger, Alexandre F. Garcia, Christine Trittermann, Stewart Coventry, Huwaida Rabie, Chris Brien, Martin Nguyen, Mark Tester and Stuart J. Roy**

1194–1206

Salinity reduces the grain yield of cereal crops. In this study, nondestructive and destructive phenotyping was used to evaluate 24 predominately Australian barley lines at 0, 150 and 250 mM NaCl. Lines with higher salinity tolerance were better able to maintain their growth rates shortly after salt treatment and exclude Na<sup>+</sup> from their shoots. This study shows that variation in shoot tolerance mechanisms unrelated to ion toxicity exists in barley and suggests that breeding new varieties with increased shoot ion-independent tolerance is possible.

*Cover illustration:* Representative confocal images of mesophyll cells showing the BCECF fluorescence distribution between the cytosolic and vacuolar compartments (see Adem *et al.* pp. 1147–1159. Image by Yuqing Huang.

The effect of elevated atmospheric [CO<sub>2</sub>] and increased temperatures on an older and modern cotton cultivar  
**Katrina J. Broughton, Michael P. Bange,  
Remko A. Duursma, Paxton Payton,  
Renee A. Smith, Daniel K. Y. Tan  
and David T. Tissue** 1207–1218

Rising atmospheric [CO<sub>2</sub>] and temperature under projected climate change scenarios may have significant impacts on the physiology and yield of cotton. We quantified the response of cotton cultivars grown in elevated [CO<sub>2</sub>] and temperature and found substantial potential to increase breeding selection in future climates. Understanding the implications of integrated environmental impacts on cotton is critical for developing cotton systems that are resilient to stresses induced by climate change.

Possible involvement of phosphoenolpyruvate carboxylase and NAD-malic enzyme in response to drought stress.  
A case study: a succulent nature of the C<sub>4</sub>-NAD-ME type desert plant, *Salsola lanata* (Chenopodiaceae)  
**Zhibin Wen and Mingli Zhang** 1219–1228

In this work we tested the response of PEPC and NAD-ME in the C<sub>4</sub>-NAD-ME subtype plant *Salsola lanata* (Chenopodiaceae) under drought stress. Only severe stress limited PEPC enzyme activity (at pH 8.0) significantly, and this was related with decreased PEPC mRNA. More phosphorylated status of PEPC enzyme in plants is under moderate stress compared with other treatments. The change of NAD-ME activity coincided with a change of leaf water content rather than the amount of  $\alpha$ -NAD-ME mRNA and protein.

Small rainfall pulses affected leaf photosynthesis rather than biomass production of dominant species in semiarid grassland community on Loess Plateau of China  
**Peifeng Xiong, Jiali Shu, He Zhang, Zhao Jia,  
Jinxi Song, Jairo A. Palta and Bingcheng Xu** 1229–1242

Rainfall pulses in water-limited regions significantly affect ecosystem structure and function. After comparing the effects of size and timing of stimulated rainfall pulses on dominant grassland species, we concluded that small pulses had a greater effect on leaf photosynthesis rather than biomass production, and the magnitude was correlated with species type and growth season. These results facilitate the regional eco-adaptability evaluation of species and prediction of vegetation succession under altered rainfall regimes.